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by

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This paper estimates a structural non-linear wage bargaining model for The Netherlands. The estimation results show a significant positive long-term impact of the average tax wedge on wages. The marginal tax rate exerts a small negative impact on wages. The impact of benefits rises with the unemployment rate.

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1Introduction

In any macroeconometric model the wage equation is of crucial importance. Indeed, the wage equation largely determines the macroeconomic impact of taxes and social benefits. Unfortunately, theoretical notions and empirical studies do not agree in this respect. Theoretical models of wage setting suggest that employers' and employees' tax rates and VAT-rates should exert the same impact on wages. Layard, Nickell and Jackman (1991, 1994) suggest that the tax wedge exerts no long-term influence on wage costs whatsoever. This contrasts to many empirical studies. For example, testing a macro wage equation for ten OECD countries, Knoester and Van der Windt (1987) find that the employers' and employees' tax rate have a significant impact on wage costs in the case of Australia, Canada, Germany, Italy, Japan, The Netherlands, Sweden and the United Kingdom. For the United Kingdom, Layard and Nickell (1986) find that only the labour tax rate of employers affects wages.

Also on how the replacement rate affects wages, theoretical and empirical studies come to different conclusions. Theoretical studies provide abundant support for such an influence. However, the empirical evidence is scarce and mixed. Most empirical studies do not detect any significant effect, although some do find a rather large impact (see Table 1).

This paper develops a theoretical wage bargaining model, which yields a non-linear wage equation with a positive long term impact of taxes on wages as a special case. The elasticity of the replacement rate depends on the unemployment rate. The wage equation is estimated on time series data of the Netherlands. By distinguishing between short-term and long-term coefficients, we reconcile the divergence between theoretical predictions and empirical estimates of various components in the tax wedge. The last section summarizes the main findings and reviews some policy implications.

2 Derivation of the wage equation

Tabel 1 Estimates of the replacement rate elasticity in wage equations

study	country	estimate
Minford (1983)	United Kingdom	0.6
Layard and Nickell (1986)	United Kingdom	0.18
Nickell (1987)	United Kingdom	0.15 to 0.35
Manning (1993)	United Kingdom	0.18 to 0.21
Central Planning Bureau (1992)	Netherlands	0.15
Lever (1991)	Netherlands	0.17
Graafland (1992a, 1992b)	Netherlands	0.31
Calmfors (1990)	Norway, Sweden	0
	Denmark	0 to 0.28
	Finland	0.18
Christensen and Knudsen (1992)	Denmark	0.05
Dolado, Malo de Molina and Zabalza (1986)	Spain	0.45
Adams and Coe (1990)	USA	0.05

The wage equation is derived from a wage bargaining model for a representative employer and employee. The outcome of the wage bargain is described by the maximization of the following Nash-function:

$$\max arg(W): \Omega = \Pi^{\alpha} V^{1-\alpha} \qquad 0<\alpha<1 \tag{1}$$

where Π and V denote the employer's and employee's utility, respectively, and α represents the relative bargaining power of the employer. The employer's utility equals the operating profits generated by the employee. These operating profits are given by the value added price (P) times labor productivity (q) minus wage costs per employee (W):[1]

$$\Pi = P \;\; q - W \tag{2}$$

The employee's utility corresponds to the surplus from working, which is the net wage offered by the employer minus the opportunity costs of taking the job (*i.e.* the reservation wage). Let T denote the total taxes and social premiums per employee. Define t as T/w, that is, t is the average tax and social premium rate. The employee's utility is then:

$$V = W(1-t) - W \tag{3}$$

where _ stands for the reservation wage. The reservation wage is a weighted average of the opportunity wage in the official labor market ($\__o$) and that in the informal sector ($\__b$):

$$W = \beta W_o + (1-\beta) W_b \tag{4}$$

The opportunity wage in the official labor market depends on the expected wage of other jobs and on the unemployment benefit. The reason is that the employee generally spends some time in unemployment before finding an alternative job. Income during unemployment equals the replacement rate (R) times the macro wage[2]. The expected wage of other jobs equals the macro wage rate (W). The time spent unemployed before finding an alternative job is assumed to be equal to the unemployment rate u . This gives:

$$W_o = \;\; u\, R\, W(1-t) + (1-u) W(1-t) \tag{5}$$

Instead of looking for another job on the official labor market, the employee can withdraw from the official labor market and seek work in the informal sector. The informal labour market

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[1] Total profits are given by operating profits minus some unspecified sunk costs. These could, for example, be hiring costs or capital costs. These sunk costs create quasi rents that make the bargaining necessary. They also generate unemployment as a necessary force to reduces the union wage claims to a level compatible with general equilibrium, that is a level such that the firms' operating profits are high enough to cover the sunk costs.

[2] In case of social insurance, the unemployment benefit is related to the previous wage and in case of government assistance to the macro wage. For a representative worker, the previous wage equals the macro wage.

consists of home production and the underground labor market. In both sectors no taxes are levied. The Social Cultural Planning Bureau (1995) reports that, on average, men spend 8 hours a week on home production and women 24 hours a week. Black labour supply of men and women equals less than one hour a week. Hence, home production forms the greatest share of informal labour supply. It is assumed that informal labor productivity is proportionally related to formal labor productivity (q), because technological progress in the official sector generally also improves labor productivity in the informal sector. The informal output price is also related to the formal consumer price (P_c), because home production is often performed to save official consumer outlays.[3] This gives:

$$W_b = \gamma q P_c \qquad \gamma < 1 \qquad \textbf{(6)}$$

γ is added to allow for the relatively low productivity in the informal labor market compared to the official labor market.[4]

After substituting equations (2) and (3) into equation (1) and deriving the first-order condition for the Nash solution, we arrive at the following wage equation:

Error! **(7)**

where t_m denotes the marginal tax rate, defined as dT/dw. Equation (7) shows that the wage outcome strikes a balance between the threat points of both bargaining parties. If the employer dominates bargaining (α=1), the employee is driven back to his threat point and the wage equals the reservation wage. If the employee dominates bargaining (α=0), in contrast, employer's utility is zero and the wage equals the producer price times labor productivity. Since a wage contract will be concluded only if the maximum wage offer ($P\,q$) exceeds the minimum wage claim (_), equation (7) implies that the marginal tax rate unambiguously reduces the wage. At a given average tax rate a rise in the marginal tax rate implies that the government absorbs a larger share of a wage increase. Hence, increasing wages becomes less attractive for the employee (Hersoug, 1984; Hersoug *et al.*, 1986; Hansen, 1996).[5]

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[3] Alternatively, one could let the output price of the informal sector be equal to the value added price times 1 plus the indirect tax rate, or equivalently, the consumer price with the terms of trade effect taken out.

[4] An alternative way of including the informal sector in the threat point of the employee is to assume that unemployed persons do not withdraw from the official labour market but earn some informal income in addition to the unemployment benefit they receive. Then, the threat point is specified as:
_ = u (RW (1-t) + δ q P_c) + (1 - u)W (1-t). This alternative equation implies that the impact of the informal sector on the threat point of the employee depends on the unemployment rate.

[5] In this aspect the wage bargaining model differs from the demand-supply equilibrium model, in which wages follow from equilibrium between labour demand and labour supply. In this type of model, the marginal tax rate raises wage costs, because it decreases labour supply (See Graafland, 1991).

To derive the wage equation to be estimated, we use the equilibrium condition W=W. After substitution of equations (4) to (6) into equation (7) and some rewriting, we arrive at:

Error! **(8)**

Equation (8) implies that, at a given marginal tax rate (t_m), the average tax rate (t), unambiguously raises the wage. Intuitively, taxes raise the relative attractiveness of working in the informal sector, thereby improving the bargaining position of the employee. In addition, equation (8) reveals that various components of the average tax rate exert the same effect on wages in the long run. The same holds true for the sum of the average and marginal tax rate and the ratio of the consumer price to the value added price (consisting of the terms of trade and indirect tax effect).[6] A third implication of equation (8) is that wage effects of the replacement rate and unemployment rate are interrelated. If unemployment is low, spells of unemployment are only short. Hence, the unemployment benefit level does not affect the alternative wage in the official sector much.[7] The influence of the unemployment rate on wages diminishes with the level of the replacement rate, becoming zero if the replacement rate equals one. A final implication of equation (8) is that labor productivity affects wages with a unitary elasticity.

If the informal economy is irrelevant for the threat point of the employee (β=1), equation (8) can be simplified to:

Error! **(9)**

The consumer price vanishes and the tax rate affects the wage only insofar changes in the average tax rate differ from changes in the marginal tax rate.

3 Estimation results

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[6] Note that if we had used the consumer price with the terms of trade effect taken out, as suggested in footnote 3, the terms of trade would also disappear from equation (8). The term P_c/P would then reduce to 1 plus the indirect tax rate.

[7] If the threat point is specified as in footnote 4, the wage effect of the tax wedge depends also on the unemployment rate. However, our empirical tests rejected the hypothesis that the wage effect of the tax wedge depends on the unemployment rate.

The data are based on the National Accounts of Statistics Netherlands and given in the appendix. The estimation period is restricted to the period from 1967 to 1993, because data of the replacement rate are not available for the period before 1965. Data of the tax rate relate to the median worker.[8] Dickey Fuller and Augmented Dickey Fuller test statistics (see Graafland and Huizinga (1988) and Graafland (1992b)) indicate that all variables included in equation (8) are integrated of the first order (some even of the second order).

Equation (8) is estimated in two alternative ways. First, we used NLS for a direct estimation of the wage level equation as specified in equation (8). Because of the long term character of equation (8), all variables are unlagged. In order to test for stationarity of the residual, we use the Durbin Watson and the LM test statistics. The advantage of this method is that the number of estimated coefficients is relatively small.

Second, we used 2SLS to estimate the wage equation in an error correction form, specified as:

$$\Delta \log W = \Sigma \varphi_i \Delta \log X_i \; - \eta(\log W_{-1} \; - \log W^*_{-1}) \qquad 0<\eta<1 \qquad \textbf{(10)}$$

The first terms considers the short-term effects (φ_i) of the explanatory variables (X_i). To deal with simultaneity between the growth in wage, producer price, consumer price, labour productivity and unemployment, we employ one year lagged values and import prices as instrumental variables. For the tax wedge we allowed the short term influence of the social premium rate paid by employers to differ from that of the rate of direct taxes and social premiums paid by employees. Also the short term effects of the replacement ratio's for social insurance benefits and for social assistance are separately estimated. The last term in equation (10) captures the error correction term defined as the difference between last years's wage level and the long term wage level as specified by equation (8). The advantage of this second method is that it tends to reduce the finite sample bias in the estimated long-run coefficients (see *e.g.* Banerjee et al., 1993, pp 214-23) and allows a simulateous estimate of the long term and short term effects.

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[8] Empirical tests showed this definition to be more relevant than the average tax wedge of all employees. This might reflect that, at the time of wage bargaining, unions have no full information about the average tax wedge of all workers and use the tax wedge of the median worker instead. Another explanation is that the tax wedge of the median worker better represents the tax wedge of the average union member if union members disproportionally consist of low income workers.

Table 2 Estimation results

Table 3 Estimated elasticities in different subperiods

	(1)			(2)		
period	1966-1975		1975-1985		1985-1993	
long term coefficients[a]						
	(1)	(2)	(1)	(2)	(1)	(2)
α		0.953	(66.9)		0.949	(126.9)
β		0.940	(48.9)		0.953	(118.6)
σ		0.025	(5.4)		0.017	(10.4)
ξ		0.741	(2.2)		0.704	(4.9)
average tax rate[a]	0.58	0.51	0.63	0.56	0.68	0.62
marginal tax rate[b]	-0.12	-0.15	-0.07	-0.12	-0.10	-0.16
short term coefficients[a]						
consumer price	0.46	0.36	0.56	0.44	0.58	0.46
_ log P_c					0.305	(3.2)
producer price	0.54	0.64	0.44	0.56	0.42	0.54
_ log(1-s)					-0.683	(3.6)
replacement rate	0.09	0.10	0.34	0.37	0.348	0.49
_ log($1-t_m$)					0.193	(5.3) (4.9)
unemployment rate[c]	-2.18	-2.38	-1.59	-1.76	-2.24	-2.47
_ log P					0.436	(4.5)
_ log q					0.213	(3.9)
_ log R_s					0.112	(3.6)
_ log R_l					0.181	(4.3)
log W - log W*					0.616	(9.2)
statistics						
R	0.999		0.999			
Adjusted standard error (*100)	1.815		0.382			
Durbin Watson coefficient	1.678		2.243			
LM(2)	2.210 [p=0.13]		1.380 [p=0.29]			
ARCH(2)	0.450 [p=0.80]		0.990 [p=0.61]			

Symbols

W wage cost

P_c consumer price

s employer's social premium rate (as a rate of wage costs)

t_l employee's tax and social premium rate (as a rate of gross wages)

t_m marginal tax and social premium rate

P value added price

q labour productivity

R_s replacement ratio of social insurance benefits

R_l replacement ratio of social assistance

[a] t-values between parenthesis

[b] One year lagged

[a] (∂W/W)/(∂t/(1-t)

[b] (∂W/W)/(∂t_m/(1-t_m)

[c] semi-elasticity, defined as (∂W/W)/∂u

Table 2 presents the estimation results. The LM(2) test is a F-test on the joint significance of the one and twice lagged residuals. The DW-test and the LM(2) test do not reject the null-hypothesis of zero autocorrelation. The Arch(2) test gives no indication of heteroskedasticity. Commenting on the long-term coefficients, we see no large differences between the estimated structural coefficients in the first and second column. Wage bargaining seems to be almost fully dominated by the employer, α equals 0.95. Furthermore, the threat point of the employee is almost fully related to the opportunity wage in the official labour market. Still, β significantly differs from 1. This implies that the threat point of the employee is also influenced by the opportunity wage in the informal sector. The value of the coefficient of the consumer price ($\delta/(1-\alpha+\delta)$) can be calculated at 0.35 (with t-value 9.4) respectively 0.25 (with t-value 11.4). Hence, the tax wedge is found to exert a significant positive long term impact on wages. This result contrasts with Layard, Nickell and Jackman (1991, 1994), who argue that taxes exert no long-term effect on wage costs. The estimates of α, β and δ further imply that the ratio between the productivity in the informal sector and official sector (γ) varies from 0.43 (with t-value 1.9) in the first column to 0.38 (with t-value 4.1) in the second column. These values fit with the relative low productivity in the informal sector. The interpretation of ε is less straightforward because this coefficient also corrects for differences in scaling of the other explanatory variables.

From these results, the elasticities of the average and marginal tax rate, the consumer and producer price, the replacement ratio and the unemployment rate can be calculated (see Table 3). For the tax rates and the consumer and producer price these elasticities show only little variation over the estimation period. In the first column the elasticity of the average tax rate is, on average, seven times larger than the (absolute value of the) elasticity of the marginal tax rate. In the second column the elasticity of the average tax rate is four times larger than the (absolute value of the) elasticity of the marginal tax rate. The negative wage effect of the marginal tax rate is supported by other studies for the United Kingdom (Lockwood and Manning, 1993), Italy (Malcomson and Sartor, 1987) and other OECD countries (Tyrväinen, 1994; Hansen et. al., 1995; Lockwood et. al., 1995[9]; Wikström et. al., 1996). Furthermore, the interdependence between unemployment rate and replacement rate implies that the elasticities of the replacement rate and the unemployment rate have varied considerably over time. At the low unemployment rates during the sixties, the replacement rate did not generate much wage pressure. The rise in unemployment rate during the seventies increased the effect of the replacement rate on wages, reaching its peak after the recession in the beginning of the eighties. In the nineties, the impact of replacement rate on wages diminishes, but it is still well above the level in the seventies. The (semi) elasticity of the unemployment rate varies inversely with the replacement rate, which has increased from 0.72 in 1966 to 0.83 in 1974 and has fallen since then to 0.70 in 1993. Finally, it is noted that the average value of the (semi) elasticity of unemployment is rather high. In most previous research for the Netherlands this elasticity varies

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[9] Lockwood et. al. (1995) find a negative impact of tax progressivity on wages for middle income groups, but a positive impact for (male white collar) high income earners and (female) low income earners.

from -0.7 in Gelauff and Graafland (1994) to -1.4 in Graafland and Verbruggen (1993). Partly this difference is explained by the non-linear specification used in this paper. If we estimate a linearized specification of equation (8), the (semi) elasticity of the unemployment rate drops from -2 to -1.5.

For the short-term coefficients in the second column, we find that the effect of the employers' rate of social premiums on wage growth exceeds that of the consumer price or employees' tax and social premium rate (although the difference is not significant). This is consistent with other studies on Dutch wages (Fase et al, 1990; Central Planning Bureau, 1992; Graafland, 1991, 1992a; Graafland and Verbruggen, 1993). The relatively large influence of employers' social premium rates on wage costs can be explained by institutional aspects of wage bargaining. In the Netherlands, collective bargaining concludes contracts for the gross wage (e.g. wage costs excluding social premiums paid by employers). If the gross wage is fixed, an unanticipated increase in the employers' tax rate will, in the short run, cause a similar change in wage costs. An unexpected increase in the employees' tax rate, in contrast, is absorbed by workers in terms of a lower net wage. In this way, unexpected changes in the employers' and employees' tax rate imply different short-run effects on wage costs. However, these effects due to nominal contracting are not likely to persist in the long run.

Significant short-term effects on wage growth are also found for the producer price, labour productivity and the replacement ratio of both government assistance and social insurance. The latter two coefficients are more or less equal. We did not find any short-term effect of the unemployment rate and thus dropped it. However, the high value of the error-correction term implies a strong feedback from last year's divergences from the long-term wage level. Almost two thirds of the difference between last year's actual wage level and the preferred long-term wage level is reversed within a year. Indeed, within three years, 90 % of the convergence towards the long-term wage level is realized.

4Conclusions and policy implications

This paper estimates a non-linear wage equation for the Netherlands. The long-term equation is derived from a wage bargaining model in which the threat point of employees involves income earned in the untaxed informal sector. The model implies that the various components of the tax wedge exert the same impact on wage costs. Wages depend also on the consumer price, the producer price, labour productivity, the unemployment rate and the replacement rate. The ways the latter two variables affect wages are related. In particular, the wage pressures generated by the replacement rate rise with the unemployment rate. Furthermore, the moderating influence of unemployment on wages falls with the replacement rate.

Estimation results for the Netherlands show a highly significant long-term impact of the tax wedge on wages. The implied elasticity of the average tax rate is about 0.5. The marginal tax rate exerts a small negative impact on wages of -0.1. Both elasticities are more or less stable over the estimation period (1967-1993). The elasticity of the replacement rate and unemployment rate, in contrast, show a large variation. The elasticity of the replacement ratio increases from 0.1 during the sixties to over 0.4 in the eighties. The semi-elasticity of the

unemployment rate varies from -1.5 during the second half of the seventies to -2.5 during the first half of the nineties.

Estimation of the dynamic effects shows that the employers' social premium rate exerts a substantial impact on wages costs in the short run, which is twice as large as the short-term wage effect of the employees' tax and social premium rate. However, the large impact is short-lived, because the estimated error correction mechanism implies that the wage rapidly converges towards its long-term level.

The findings in this paper yield important policy implications. First, the significant long-term influence of the tax wedge on wage costs implies that tax policy affects equilibrium unemployment. This conclusion contrasts with Layard, Nickell and Jackman (1991, 1994), who argue that the tax wedge leaves equilibrium unemployment unaffected. The negative influence of the marginal tax rate implies that tax base broadening - *i.e.* reducing marginal rates while leaving average rates unaffected - raises wage costs. In the short run, a decrease in the employers' social premium rate seems to be the most effective instrument to moderate wages. The estimation results further suggest that at high levels of unemployment a reduction in unemployment benefits is particularly effective in reducing wage costs.

Appendix Data

	W	P_c	P	q	t	s	t_l	t_m	u	R_s	R_l
1965	0.162	0.314	0.388	0.423	0.348	0.144	0.233	0.335	0.006	81.805	63.400
1966	0.180	0.331	0.402	0.435	0.363	0.158	0.238	0.352	0.008	82.398	63.860
1967	0.196	0.340	0.411	0.466	0.373	0.165	0.244	0.410	0.017	79.289	61.450
1968	0.213	0.349	0.419	0.500	0.390	0.178	0.252	0.427	0.015	81.340	63.040
1969	0.241	0.370	0.440	0.535	0.402	0.181	0.263	0.460	0.011	86.166	66.780
1970	0.272	0.386	0.454	0.569	0.408	0.183	0.270	0.468	0.010	83.637	64.820
1971	0.310	0.417	0.484	0.589	0.432	0.190	0.291	0.476	0.013	85.608	65.470
1972	0.348	0.451	0.524	0.619	0.444	0.193	0.305	0.494	0.020	84.146	65.620
1973	0.404	0.490	0.558	0.667	0.473	0.211	0.324	0.490	0.021	86.276	66.450
1974	0.467	0.537	0.596	0.702	0.488	0.216	0.340	0.520	0.024	91.813	70.090
1975	0.526	0.591	0.645	0.690	0.483	0.215	0.336	0.520	0.032	90.197	75.410
1976	0.584	0.644	0.693	0.739	0.490	0.217	0.343	0.531	0.035	89.393	76.640
1977	0.635	0.683	0.729	0.756	0.485	0.213	0.339	0.533	0.033	88.484	75.900
1978	0.680	0.714	0.763	0.778	0.486	0.211	0.342	0.542	0.034	88.609	76.920
1979	0.722	0.745	0.782	0.795	0.489	0.213	0.344	0.550	0.032	88.274	76.120
1980	0.767	0.797	0.808	0.801	0.493	0.216	0.345	0.564	0.036	84.686	76.080
1981	0.802	0.847	0.830	0.819	0.492	0.216	0.347	0.595	0.056	83.990	75.930
1982	0.855	0.892	0.880	0.844	0.511	0.215	0.368	0.598	0.079	82.090	75.480
1983	0.890	0.917	0.898	0.872	0.541	0.222	0.396	0.634	0.097	83.660	76.360
1984	0.898	0.936	0.905	0.915	0.528	0.221	0.382	0.651	0.097	82.206	74.240
1985	0.915	0.957	0.918	0.922	0.518	0.220	0.369	0.631	0.087	77.091	72.090
1986	0.939	0.959	0.949	0.934	0.507	0.220	0.359	0.624	0.084	76.923	70.680
1987	0.954	0.961	0.956	0.933	0.508	0.216	0.364	0.617	0.085	75.689	69.790
1988	0.964	0.967	0.973	0.952	0.504	0.215	0.360	0.614	0.084	74.842	68.960
1989	0.971	0.978	0.989	0.980	0.495	0.204	0.359	0.612	0.077	71.793	66.900
1990	1.000	1.000	1.000	1.000	0.471	0.205	0.327	0.574	0.070	70.100	64.960
1991	1.042	1.032	1.014	1.009	0.474	0.212	0.324	0.578	0.066	70.276	64.590
1992	1.091	1.063	1.031	1.009	0.483	0.214	0.332	0.586	0.067	70.127	64.510
1993	1.125	1.085	1.038	1.011	0.483	0.214	0.333	0.583	0.077	74.276	63.670

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